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**WATER QUALITY AND POLLUTION CONTROL
STUDY, RAPPAHANNOCK RIVER BASIN**

**Federal Water Pollution Control Administration
Charlottesville, Virginia**

March 1967

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WATER QUALITY
AND
POLLUTION CONTROL STUDY

RAPPAHANNOCK RIVER BASIN

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CB-SRBP Working Document No. 10
FWPCA
Middle Atlantic Region
March 1967

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I. INTRODUCTION

A. Purpose and Scope

Under the provisions of the Federal Water Pollution Control Act (33 USC et seq), Section 3(a), the Secretary of the Interior is authorized to make joint investigations with other Federal agencies, with State Water Pollution Control Agencies and interstate agencies, and with the municipalities and industries involved, of the condition of any waters in any State or States and of the discharges of any sewage, industrial wastes, or substance which may adversely affect these waters. These investigations are for the purpose of preparing and developing comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof.

This Working Document, by describing the immediate needs for controlling water pollution in the Rappahannock River Basin in northeastern Virginia, represents the first step in the development of a comprehensive program to control water pollution in the Basin.

The principal objectives of the investigation and report are as follows:

1. Outline existing and potential water quality problems in areas producing significant municipal, industrial, and/or other wastes, and identify sources.
2. Summarize immediate pollution control needs and estimated costs for providing these needs.

3. Suggest various local and basin-wide pollution control measures which should be considered in planning a comprehensive program for the Basin.

B. Acknowledgments

The cooperation and assistance of the following Federal, State, and local agencies are gratefully acknowledged:

U. S. Soil Conservation Service, Charlottesville, Virginia

U. S. Geological Survey, Charlottesville, Virginia

U. S. Army Corps of Engineers, Norfolk, Virginia

Virginia State Water Control Board, Richmond, Virginia

Virginia Department of Health, Richmond, Virginia

Virginia Division of Water Resources, Charlottesville,
Virginia

National Planning Association, Washington, D. C.

Local County and Municipal Officials

Local Industrial Representatives

II. GENERAL

A. Source of Information

Current pollution abatement programs, existing water quality, and estimated costs for needed facilities were evaluated employing the following sources of information:

1. Sewage and industrial files of the Virginia State Water Control Board.
2. Existing water quality and treatment plant data obtained from files of Federal, State, and local agencies.
3. Publications of various Federal, State, and local agencies.
4. Personal communications with public health oriented individuals associated with pollution abatement in the Basin.

For evaluations of future water quality requirements, county population and industrial productivity projections developed by the National Planning Association were employed. The 1960 Census Report was used as a base from which individual community projections were made. Where applicable, industrial loadings were projected by type of industry on an individual production basis.

Although limited data on tributary water quality and assimilative capacities were available, secondary treatment of

all significant waste discharges in the Basin, with 85 per cent removal of the biochemical oxygen demand, has been assumed by the Federal Water Pollution Control Administration, Chesapeake Bay-Susquehanna River Basins Project, to be a minimum requirement for the purpose of this report.

Cost estimates for upgrading present facilities as required to provide the desired degree of treatment were obtained for the most part from consulting engineers who have completed studies of needed treatment facilities. For communities not having engaged an engineer, cost estimates were made of the plant proper, employing construction cost information from the Public Health Service Publication No. 1229, "Modern Sewage Treatment Plants - How Much Do They Cost," and updating these costs with the Public Health Service - Sewage Treatment Plant current cost index (PHS-STP 105.0).

In areas where future water quality problems are anticipated, methods proposed for future actions are given for consideration only, since detailed evaluations of alternatives and comparisons of benefits have not been made.

B. State Stream Classifications

Public hearings on proposed stream standards for the estuarine reaches of the Basin have been scheduled for March 1967; however, at the writing of this report, the Virginia State Water Control Board has not established specific water quality

objectives for either State-wide or individual stream application. The policy in the past has been to consider each waste discharged on its own merits, taking into consideration downstream water uses and assimilative capacity of the receiving waters. However, with certain modifications and/or expansion, the following basic criteria are used: (1) dissolved oxygen not lower than 4 milligrams per liter in the stream; (2) no appreciable settleable or floating solids; (3) no noticeable coloration or discoloration of the receiving stream; (4) toxic substance to be reduced below the toxicity limit of the stream; (5) no appreciable change of pH of the receiving stream; and (6) stream flow for design of sewage treatment facilities equal to minimum average 7-day low flow occurring in a 10-year frequency.

The Water Control Board is expected to adopt water quality standards for the estuarine reaches of the Basin by June 1967.

III. SUMMARY

A. Findings

1. The Rappahannock River Basin, extending 160 miles in a southeasterly direction from the divide on the Blue Ridge Mountains to the Chesapeake Bay, is divisible into three sections, the headwaters, central, and lower areas, the boundaries for the areas being based upon economic, population, and geographic considerations. (See Figure 1)

2. In the rural headwaters area, all municipalities have secondary treatment, with the exception of the small community of Remington, which discharges a primary effluent to the Rappahannock River.

Localized problems exist in several stream reaches in the headwaters region, including degraded conditions in Mountain Run at Culpeper, where the overloaded secondary plant is being enlarged; degraded conditions in Popular Run at Orange, due to an industrial waste discharge from the Kentucky Flooring Company of Virginia; and bacterial pollution in the Rappahannock River below Remington, resulting from the primary discharge of the small municipal treatment plant.

3. In the central area, which includes the populous Fredericksburg Area, the Rappahannock River is severely degraded by industrial and municipal waste discharges. Zero dissolved oxygen levels, fish kills, and other nuisance conditions occur

for three miles below Fredericksburg during low flow periods, and water quality is affected for ten miles downstream.

The principal contributor to the problem is the Food Machinery Corporation, American Viscose Division, which discharges approximately 30 mgd of untreated waste to the river. The 48,000 population equivalent (P.E.) of the discharge is about three times the total population of the Fredericksburg urban area. Municipalities in the area which contribute to the problem include Fredericksburg, Falmouth Sanitary District, and the Ferry Farms Subdivision which contribute primary treated wastes with P.E.'s of 11,000, 225, and 650, respectively, and the Tylerton Subdivision which discharges approximately 0.03 mgd of untreated sewage.

4. Localized water pollution associated with boating activity is the principal problem in the rural lower region. Bacterial pollution exists in Urbanna Creek, Broad Creek, and Carter Creek, and the State Department of Health has placed restrictions on the direct marketing of shellfish from approximately 1200 acres of beds.

The Town of Urbanna contributes a P.E. of approximately 100 to Urbanna Creek from an outmoded and structurally unsound primary treatment plant. The Tide's Inn resort at Irvington has contributed to potential nuisance conditions in Carter Creek by poor operation practices at their secondary treatment plant.

The Town of Kilmarnock has septic tank discharges which flow to Corrotoman River, Eastern Branch.

5. By-passing of raw sewage flows during wet seasons, as a result of storm and ground water infiltration of sanitary sewer systems, lowers treatment plant over-all effectiveness in towns throughout the Rappahannock Basin. Also, in some towns, plant operators have various other municipal duties, and the part-time attention given to treatment plants is inadequate.

B. Immediate Pollution Control Needs

1. Waste Treatment

The most pressing need in the Basin is for the provision of adequate treatment facilities to control pollution at its source. Current treatment practices, needs, and cost estimates for municipalities and industries in the study area are given in Table I.

A general summary of immediate waste treatment needs in the study area is given below:

Municipal

- | | |
|---|-----------|
| a. Four municipalities to provide secondary treatment plants. | \$867,000 |
| b. Two municipal secondary treatment plants to be enlarged | \$944,410 |

c. One municipality to expand sewerage systems	\$250,000
d. One proposed Sanitary District to provide a new secondary treat- ment plant and interceptor system	\$950,000
e. One municipality to provide a new sewerage system, including sewage treatment plant	\$650,000
Total Municipal	\$3,661,410

Industrial

a. One large industry to provide secondary treatment	\$800,000*
b. One small industry to reduce solids in wastes discharged by in-plant changes or waste treatment	<u>undetermined</u>
Total Industrial	\$800,000

2. Flow Regulation

To adequately protect and enhance water quality in the
face of population and industrial growth, urbanization, and

* Cost for pilot plant only.

technological change, water pollution control action, in addition to the provision of conventional waste treatment facilities, is needed in areas where stream flows are low in comparison to the existing and/or projected residual BOD loads which the stream must assimilate.

Reservoir storage to provide supplemental flow for water quality control is a possible solution to supplemental water pollution control needs in the two areas in the Rappahannock Basin where a need for greater than 85 per cent removal of the BOD in waste discharges is indicated.

The areas requiring flow regulation and proposed reservoirs are listed in Table II.

3. Special Studies

Additional investigations are needed in several areas in the Basin to provide the basis for comprehensive evaluations of existing or potential pollution control needs. Table III summarizes these study needs.

4. Institutional Practices

A need for action on pollution control measures by various Federal, State, and local institutions in the Rappahannock Basin is indicated by the findings of this study. Table IV summarizes needed institutional practices which would enhance and strengthen pollution control programs.

TABLE 1
CURRENT TREATMENT PRACTICES AND NEEDS
(MUNICIPAL AND INDUSTRIAL)

Location	Population Served	Present Treatment	Immediate Treatment Action Needed	Estimated Project Cost	State or Other Action
<u>Fredericksburg Area</u>					
Food Machinery Corporation American Viscose Division	48,000 *	None	Secondary	\$800,000 (pilot plant construction only)	Under orders by WCB. Pilot plant under construction.
City of Fredericksburg 1960 population 13,639	14,350	Primary	Secondary	\$570,000	Under orders by WCB. Final design complete. ***
Southeastern Stafford County, including Falmouth, Ferry Farms, and Tylerton	1,650	Primary and an 0.03 mgd untreated discharge	Secondary	\$950,000 (includes enlarged collection system and STP)	Under orders by WCB. Preliminary design. Referendum required.
<u>Culpeper</u> 1960 population 2,412	5,000	Secondary	Enlarged capacity	\$694,410	Under orders by WCB. Money allocated and plant under construction. 42 per cent complete 2/67.
<u>Remington</u> 1960 population 288	300	Primary with no chlorination	Secondary	\$70,000 **	WCB has advised the town that chlorination should be installed in near future

TABLE 1 (Continued)
CURRENT TREATMENT PRACTICES AND NEEDS
(MUNICIPAL AND INDUSTRIAL)

Location	Population Served	Present Treatment	Immediate Treatment Action Needed	Estimated Project Cost	State or Other Action
<u>Urbanna</u> 1960 population 512	150	Primary	Secondary	\$100,000**	No action. Additional data on boat pollution is needed.
<u>Kilmarnock</u> 1960 population 927	950	Central Septic Tanks	Secondary	\$127,000	Preliminary design completed. Referendum required.
<u>Orange Area</u> Kentucky Flooring Company of Virginia	170*	None	In-plant modifications or secondary	Undetermined	Under study by owner and WCB.
<u>Town of Orange</u> 1960 population 2,955	3,000	Secondary	Enlarged capacity	\$250,000	No action. (The situation is not critical but potential problems exist.)
<u>Warrenton</u> 1960 population 3,522	2,300	Secondary	Expanded Sewerage System	\$250,000	Final design complete.
<u>Warsaw</u> 1960 population 549	549	Private Septic Tanks	Sewerage System including secondary STP.	\$650,000 (including collection system)	Preliminary design complete. Seeking funds.

* Estimated population equivalent

** Cost of treatment plant only, based on current construction costs (PHS-STP Index 105.0)

*** Applied for Federal Grant

TABLE II
FLOW REGULATION FOR WATER QUALITY CONTROL

Location	Responsibility	Existing or Potential Need
Culpeper	Soil Conservation Service (Mountain Run Watershed Dams 18 and 50)*	Mountain Run - storage to provide supplemental flow for water quality control.
Fredericksburg	Corps of Engineers (Salem Church Reservoir)**	Rappahannock River - 130,400 acre-feet of storage to provide supplemental flow for water quality control.

* Storage for flow regulation was not included in planning.

** Storage for flow regulation included in planning.

TABLE III
SPECIAL STUDIES NEEDED IN THE BASIN

Location	Responsibility	Need
Basin-wide	FWPCA and State of Virginia	Determine assimilative capacities of all existing and proposed waste receiving streams in the Basin.
Lower Basin (Fredericksburg to Chesapeake Bay)	FWPCA and State of Virginia	Conduct intensive water quality studies in the estuary (including boat pollution).
Warrenton (This Town is located on the divide of the Potomac and Rappahannock River Basins)	State of Virginia and Town of Warrenton	Conduct comprehensive studies to determine which River Basin should receive future waste discharges.

TABLE III (Continued)
SPECIAL STUDIES NEEDED IN THE BASIN

Location	Responsibility	Need
Orange (This Town is located on the divide of the Rappahannock and York River Basins)	State of Virginia and Town of Orange	Conduct comprehensive studies to determine which River Basin should receive future waste discharges.
Culpeper	FWPCA and Soil Conservation Service	Study need for flow regulation in Mountain Run Watershed Development.
Basin-wide	FWPCA and State of Virginia	Develop basin-wide comprehensive program and for planning purposes utilize data compiled from the above studies in mathematical simulation of the river system.

TABLE IV
INSTITUTIONAL PRACTICES NEEDED IN THE BASIN

Location	Responsibility	Need
Basin-wide	State of Virginia	Prepare and adopt standards on intrastate streams.
Basin-wide	State of Virginia	Consider legislation to provide appropriations for State participation in grants for construction of sewage treatment works.
Lower Basin	Congress of the U. S. and State legislature	Strengthen boat pollution laws.
Basin-wide	State of Virginia and local governments	Enhance treatment plant operator efficiency by greater emphasis on operator training schools and State certification.

TABLE IV (Continued)

Location	Responsibility	Need
Basin-wide	Local Governments	Reduce infiltration problems by strengthening plumbing codes on house connections and emphasizing infiltration tests on new construction.
Fredericksburg Area	State of Virginia and local government	Consider establishment of a centralized pollution control authority for the Area.

IV. DESCRIPTION OF THE STUDY AREA

The Rappahannock River Basin embraces approximately 2,700 square miles in northeastern Virginia and extends 160 miles in a southeasterly direction from the eastern slopes of the Blue Ridge Mountains to the Chesapeake Bay.

The 60-mile wide headwaters area and the 10 to 20-mile wide middle and lower tidewater areas form a tomahawk-shaped basin which is a geographic reminder of the Indian origin of the name "Rappahannock," interpreted by authorities on Algonquin dialects as "river current which flows back again." This back flow occurs with the incoming tide which affects the stream from the mouth to the "fall line" at Fredericksburg, a distance of about 107 miles.

Headwaters lie in Rappahannock County, approximately 80 miles northwest of Fredericksburg in the Blue Ridge physiographic province where the rugged topography rises in elevation from 500 to over 3,500 feet above mean sea level. The geological formations in the mountainous regions consist of quartzites and granites, and stream channels are steep with few flood plains.

The main tributaries in the headwaters area are Thornton and Hazel Rivers and Mountain Run, all of which are small. The principal tributary, the Rapidan River, flows eastward out of Madison, Orange, and Culpeper Counties and joins the main stem 122 miles above the mouth.

The middle reaches are in the Piedmont Province, a plateau lying between the eastern foot of the Blue Ridge Mountains and the Fall Zone. Topography is well rounded; formations consist of mingled crystalline and metamorphic rocks, and the stream flows in a sinuous, entrenched channel with limited flood plains.

The broader headwaters area, draining into the narrow middle reach where topography, stream patterns, and geology are conducive to floods, has produced gage height variations near Fredericksburg of greater than 25 feet.

Below the Fall Zone at Fredericksburg, the stream meanders for about 40 miles through the flat Coastal Plain where unconsolidated sediments of sand, gravel, and fossil shells derived from the mountainous regions to the west are laid down on a basement rock of granite, and for the remaining 67 miles to the mouth, typically estuarine reaches range from two to four miles in width.

The watershed includes all of four Counties: Culpeper, Madison, Rappahannock, and Richmond, and portions of 11 Counties: Caroline, Essex, Fauquier, Greene, King George, Lancaster, Middlesex, Orange, Spotsylvania, Stafford, and Westmoreland. The Basin Area is approximately one-seventh of the total State Area.

Mean flows in the Rappahannock River and its tributaries, based on the last 19 years of record from U. S. Geological Survey data, are as follows:*/

* Drought Flows in Virginia Rivers, Virginia State Water Control Board

RAPPAHANNOCK RIVER BASIN

Gaging Station Location	Mean Flow (cfs)	Minimum Mean Daily Flow Return Period		
		2 Yr.	5 Yr.	10 Yr.
Rappahannock River near Warrenton	190	7	2	1.2
Rush River at Washington	14.2	---	---	0
Thornton River near Laurel Mills	159	---	---	1.1
Hazel River at Rixeyville	330	27	6.6	3.9
Rappahannock River at Remington	657	38	10	6.8
Mountain Run near Culpeper	15.3	---	---	0.1
Rapidan River near Ruckersville	154	12	4.5	3.8
Robertson River near Locust Dale	210	19	10	2.6
Rapidan River near Culpeper	515	37	13	4.1
Rappahannock River near Fredericksburg	1,655	112	67	10
Cat Point Creek near Montross	39.2	1.2	0.1	0
Piscataway Creek near Tappahannock	30.6	---	---	0

V. WATER POLLUTION PROBLEMS, NEEDS, AND COSTS

For discussion purposes, the Rappahannock River Basin may be subdivided into three areas with boundaries based on physiographic and economic characteristics (see Figure 1). Pollution summaries of the three sub-basins follow.

A. Headwaters Area

The upper or headwaters area is largely rural, with more than 84 per cent of the population residing on farms or in rural residential areas. Warrenton, Orange, and Culpeper are the only population centers having 2400 persons or more. Four other small towns had a total 1960 population of 4,594.

The principal industry in the region is sawmilling and logging; but small industries, including furniture and other wood products, wearing apparel, metal products, and electrical equipment manufacturing, are scattered through the area.

Municipal areas having significant waste loads and/or existing or potential pollution problems are discussed as follows:

1. Town of Warrenton

Warrenton, the County Seat of Fauquier County, is at the intersection of U. S. Routes 29 and 211 and is approximately 42 miles southwest of Washington, D. C. The municipal area is approximately divided by the ridge line between the Potomac and Rappahannock River Basins. The water supply comes from Cedar

Run in the Potomac Basin, and the waste treatment plant discharges to Great Run, a small tributary of the Rappahannock River.

The present population within the Town limits is 4,100; however, approximately 8,000 persons reside in the municipal area. Projections for the area show a population increase of about 67 per cent by the year 2000.

The Town is served by a secondary treatment plant designed for a population equivalent of 6,000.

Waste Treatment Facilities
Town of Warrenton

Type of Treatment	Design Average Flow	Present Average Flow	Receiving Stream
Secondary (Standard Rate Trickling Filters)	0.6 mgd *	0.23 mgd	Great Run

* Drying beds designed for 0.5 mgd

a. Existing and Potential Problems

To maintain water quality in Great Run, the State Department of Health estimates that 90 per cent of the BOD in Town wastes must be removed consistently by the municipal waste treatment plant, but efficient plant operation could be adversely affected by infiltration which has increased flow to the plant by 300 per cent during rainstorms.

The design capacity of the municipal treatment plant will probably be exceeded in the near future if flow from a

proposed expanded sewerage system in the Cedar Run Area is collected and pumped to the plant.

b. Action Pending and Required

Engineers for the Town have completed and submitted plans for an expanded sewerage system to State agencies for approval, which includes interceptors and a pumping station designed to provide sewage collection in the Cedar Run Watershed for a ten-year projected population of 7,000. Capacity is provided for additional areas of Fauquier County, if the Fauquier County Sanitary Authority elects to enter into a cooperative agreement with the Town. The estimated cost of the proposed system is \$250,000. As proposed, waste water collected in the Cedar Run Area would be pumped over the ridge line to the existing treatment plant until flow reaches design capacity, at which time additional treatment capacity would be required.

The Town has applied to the State for a permit to discharge treated waste water to the Occoquan Creek Watershed which is presently under a moratorium set by the State Water Control Board. If the permit is granted, present plans call for a future waste treatment plant to be built downstream on Cedar Run, a small tributary of Occoquan Creek which flows through several communities in Fauquier and Prince William Counties. If the future treatment plant is not built in the Cedar Run Watershed,

an alternate plan would involve the enlargement of the existing municipal plant, and all future wastes originating in the Cedar Run Watershed in the Potomac Basin would be pumped to the Rappahannock Basin for treatment and discharge. Because of the high degree of treatment required, including removal of nutrients, for waste discharges to the Occoquan Creek Watershed, it may be more economical to enlarge the existing plant as required and pump Cedar Run wastes to the existing site. However, an analysis of comprehensive pollution abatement plans for the two Basins is suggested before a final decision is made.

The assimilative capacity of Great Run should be studied and compared with projected waste discharges from the existing waste treatment plant so that plans for additional treatment facilities may be expedited as required to assure that overloaded conditions at the existing plant will not develop. A preliminary cost estimate for a new plant is \$450,000.

The infiltration problems should also be investigated and corrected.

2. Remington - Fauquier County

Remington, a small community with an approximate population of 300, is located at the intersection of U. S. Route 29 and State Route 661. The Southern Railway crosses the Rappahannock River nearby. Waste treatment facilities consist of the following:

Waste Treatment Facilities
Remington, Virginia

Type of Treatment	Design Average Flow	Present Average Flow	Receiving Stream	Minimum Mean Discharge 7-Day Duration 10-Year Occurrence Frequency
Primary (Imhoff Tank)	0.075 mgd	0.030 mgd	Rappahannock River	10 cfs
No chlorination is provided				

a. Existing and Potential Problems

At Kellys Ford, a swimming area five miles downstream from Remington, bacterial counts of 11,000 (MPN) have been found, and analysis of samples taken upstream and downstream from Remington by State agencies have indicated that Remington is the principal source of the bacterial pollution. Other evidence of degradation, including algal growths, were noted during low flow periods. Stream analysis made by the State Water Control Board in 1966 indicated that the river recovered from the effects of the Remington discharge within one mile downstream except for bacterial pollution.

b. Action Pending and Required

The plant operators are planning to extend the effluent line from the treatment plant to the center of the River to provide more rapid mixing and dilution with the receiving stream.

Chlorination facilities should be installed immediately to reduce bacterial pollution, and plans for secondary treatment

should be started. Cost for secondary facilities is estimated to be \$70,000.

3. Town of Culpeper - Culpeper County

Culpeper, the County Seat of Culpeper County, was surveyed in 1749 by the young County Surveyor, George Washington. U. S. Routes 29 and 522 intersect in the Town; the Southern Railway passes through; and the Town is centrally located in one of the leading dairy farming Counties in the State. There are varied small industries in the Town, including furniture, wearing apparel, and metal products manufacturing, and all significant industrial discharges enter the municipal sewer system. Municipal water needs are supplied by a dual purpose structure, including 531 acre-feet of municipal water storage, located upstream on Mountain Run, a small tributary of the Rappahannock River. The Town waste treatment plant discharges into this stream in the Culpeper Area.

Population projections by the National Planning Association indicate an increase of about 52 per cent by the year 2000.

Waste Treatment Facilities
Town of Culpeper, Virginia

Type of Treatment	Design Average Flow	Present Average Flow	Receiving Stream	Minimum Mean Discharge 7-Day Duration 10-Year Occurrence Frequency
Existing: Secondary (Standard Rate Trickling Filter)	0.35 mgd	0.5 mgd	Mountain Run	0.1 cfs
Under Construction: (High Rate Trickling Filter)	1 mgd		Mountain Run	

a. Existing and Potential Problems

The degraded condition of the receiving stream prompted the State Water Control Board to require additional treatment capacity, and improved and enlarged secondary treatment facilities are under construction at the existing treatment plant site (approximately 45 per cent complete in February 1967). When flow approaches the design capacity of the enlarged plant, daily removals of 90 per cent of the influent BOD will be required to protect water quality in the receiving stream, according to preliminary studies conducted by the Water Control Board. The studies indicated the assimilative capacity of Mountain Run to be about 200 pounds of BOD per day with a stream flow of 5 cfs to maintain an average minimum dissolved oxygen level of 5 mg/l.

The Supplemental Work Plan for the Mountain Run Watershed^{*/}, presently in the final phases of review and approval, includes plans for a new multi-purpose structure on Mountain Run which will provide 1,000 acre-feet of additional municipal water supply storage for Culpeper. Also included is a floodwater retarding structure on Ball Run, a tributary of Mountain Run upstream from Culpeper. Preliminary drought flow studies made by the Virginia State Water Control Board indicate that additional impoundments in the Watershed may result in flows in Mountain Run being reduced to critical levels during dry seasons.

b. Action Pending and Required

Additional hydrological and assimilative capacity studies of the Mountain Run Watershed should be made to determine if water quality will be endangered by the Town waste treatment plant discharges in the future. Storage for flow regulation in the proposed Mountain Run Watershed project or advanced waste treatment of the Town waste discharges may be required to protect the water quality of Mountain Run.

4. Town of Orange

Orange, the County Seat of Orange County, is at the intersection of U. S. Route 15 and State Route 201 and is served by the Southern and the C & O Railways.

^{*/} Supplemental Work Plan for the Mountain Run Watershed, Soil Conservation Service, Culpeper, Virginia.

This Town is similar to Warrenton, in that the ridge line between two river basins nearly divides the Town, and future growth in the area could be in either the York or Rappahannock Basins.

Principal industries include fabrics, metal, and wood products manufacturing. The Town has also acquired approximately 200 acres south of the Town in the York River Basin which is to be developed for industry.

Construction of a new water treatment plant in the Rappahannock Basin with a capacity of 2 mgd has been approved by the Town, with construction scheduled to start in the near future.

Population projections by the National Planning Association indicate limited growth for the area, with less than ten per cent increase by year 2000; however, the new water plant and the industrial park will enhance growth possibilities.

A secondary treatment plant designed for a population equivalent of 3,700 is located west of the Town on Popular Run; however, the effluent is piped to the Rapidan River, a tributary to the Rappahannock River.

Waste Treatment Facilities
Town of Orange, Virginia

Type of Treatment	Design Average Flow	Present Average Flow	Receiving Stream	Minimum Mean Discharge 7-Day Duration 10-Year Occurrence Frequency
Secondary (High Rate Trickling Filter)	0.37 mgd	0.24 mgd	Rapidan River	11 cfs

The plant is designed so that plant capacities can be increased to 0.65 mgd by expanding primary facilities and modifying secondary facilities.

Approximately 0.08 mgd or one-third of the existing flow to the waste treatment plant originates in the York Basin.

a. Existing and Potential Problems

Degraded water quality in Popular Run is primarily caused by an untreated industrial effluent from the Kentucky Flooring Company of Virginia. The industry uses approximately 50,000 gallons of water per month and discharges to a storm drainage ditch which flows to Popular Run. The industrial discharge contains approximately 1,750 mg/l suspended solids, of which about 93 per cent are volatile, according to a sample analyzed by the State Water Control Board. The solids are in the overflow from settling tanks which settle the wash water from scrubbers installed by the Company to eliminate air pollution problems caused by the exhaust from sawdust collectors. Tannic acid in the waste, reacting with iron in the stream, causes precipitation and coloration for approximately one mile downstream. Storm and ground water infiltration of sanitary sewers creates nuisance conditions in the area. During wet seasons, flow at the municipal waste treatment plant sometimes increases by 650 per cent, resulting in by-passing and other operational problems.

Sewers are sometimes surcharged, causing manholes to overflow to streets and storm drains. These overflows are probably the source of the bacterial pollution indicated by the high coliform densities found by the Water Control Board in samples taken in the storm drainage ditch mentioned above.

The only other significant industrial waste discharge in the area is an organic tint from a fabrics industry which contributes a small BOD load to the municipal waste treatment plant. If anticipated increases in water usage occur after the new water treatment plant is constructed, overloaded conditions at the waste treatment plant could develop in the near future. No water quality problems are on record in the Rapidan River; however, further studies are needed to determine the assimilative capacity of the River.

b. Action Pending and Required

The State Water Control Board is studying the Popular Run pollution situation to determine the most feasible solution to the problem. Further treatment of the Flooring Mill effluent, possibly by chemical precipitation, may be required. The correction of the infiltration problem would reduce operation problems at the municipal sewage plant and reduce the bacterial pollution of Popular Run resulting from raw sewage overflows at manholes during storms.

The Town has recently smoke-tested the municipal sewer system in an attempt to locate infiltration problem areas, and plans are being made to conduct more extensive investigations. Cost estimates for correcting the infiltration problem have not been made, but immediate action is needed.

In preparation for increased loads anticipated after the new water system is developed, the waste treatment plant should be expanded to the ultimate design capacity of 0.65 mgd. Stream studies are needed to determine the degree of treatment required, but improvements to provide conventional secondary treatment are estimated to cost \$250,000.

A comprehensive plan for the area is needed to determine the most feasible means of disposing of future wastes originating on the two sides of the ridge line. Future growth in the area will probably take place south of the Town in the York Basin, in the area proposed for industrial development. Disposal of wastes originating in this area will involve either the pumping of the wastes into the Rappahannock Basin or the construction of a new plant in the York Basin. Since the water supply needs are originally met by withdrawals from the Rapidan River, waste discharges to the York Basin would result in decreased flow in the Rapidan River, possibly affecting downstream water quality.

B. Central Area

The Central Area, containing the City of Fredericksburg, is the economic and population center of the Rappahannock River Basin. The Area is part of what has been named the Metropolitan Corridor, which includes the four large metropolitan complexes of the State of Virginia, namely: Arlington, Alexandria, and Fairfax; Richmond, Petersburg, and Hopewell; Hampton and Newport News; and the Norfolk-Portsmouth Area.

The principal industry in the Rappahannock Basin, a large cellophane manufacturing plant, is located in the Central Area. The major water pollution problems in the Rappahannock River are downstream from this industry. All significant waste discharges which contribute to pollution problems in the central reaches of the River originate in and around the City of Fredericksburg. A summary of pollution in the Area follows:

1. Fredericksburg Urban Area

The Fredericksburg Urban Area, defined as the City of Fredericksburg and the four surrounding political districts (Chancellor and Courtland Districts in Spotsylvania County and Hartwood and Falmouth Districts in Stafford County), is located approximately 50 miles southwest of Washington, on U. S. Route 1. The Area is served by the Richmond, Fredericksburg, and Potomac Railway, and Interstate Highway 95 passes west of the City.

The water supply for the City of Fredericksburg system, which also serves the Falmouth Sanitary District, draws raw water from a canal which receives its flow from a diversion created by a low-level dam located above the City in the Rappahannock River. Industries in the area utilize the upper estuary as a major source of raw water, while surrounding communities, including Ferry Farms Subdivision, utilize wells.

The population of the Area is expected to increase more than twofold by the year 2000; however, growth of industries having significant industrial waste problems is expected to be moderate to light.

Municipal and industrial wastes totaling nearly 32 million gallons are discharged daily to the Rappahannock River in the Fredericksburg Area. Approximately two million gallons of the total receive primary treatment, and the remaining 30 million gallons are discharged untreated. (see details on page V - 16)

Waste Discharges in the Fredericksburg Urban Area

Location	Population Served	Present Discharge (mgd)	Type of Treatment Received	Receiving Stream
American Viscose Corporation	48,000 *	30	None	Rappahannock River
City of Fredericksburg	14,350	1.5	Primary	Rappahannock River
Falmouth Sanitary District	350	0.035	Primary	Rappahannock River
Ferry Farms Subdivision	1,000	0.1	Primary	Rappahannock River
Tylerton Subdivision	300	0.03	None	Rappahannock River
Total	64,000	31.665		

* Population equivalent

The Fredericksburg municipal waste treatment plant also serves areas in Spotsylvania County, including the Four Mile Fork Sanitary District and the Spotsylvania Service Authority. At present, approximately 86 per cent of the contributing population is within the City; however, consulting engineers estimate that the City's contribution will be reduced to about 61 per cent by the year 2000.

One of the largest cellophane plants in the world, owned by the American Viscose Corporation, a division of Food Machinery Corporation, is located immediately downstream from Fredericksburg in Spotsylvania County. Present employment is about 2,100 persons, making it the largest employer in the Basin.

The plant discharges waste water to the Rappahannock River having the following characteristics: pH, 2.7; BOD, 8,200 lbs/day.

The plant has followed a continuing program of process improvements and modifications over past years which has reduced the BOD load of the waste by approximately 50 per cent; however, the present waste load of 8,200 pounds of BOD per day, having a population equivalent of about three times the total urban population of the Central Area, continues to be the principal waste discharge in the Basin.

The Falmouth Sanitary District and the Ferry Farms Subdivision each have primary sewage treatment plants, while the Tylerton Subdivision discharges untreated wastes. All are in Stafford County, and all discharge to the Rappahannock River. The combined discharges from all municipalities in the Fredericksburg urban area, including occasional by-passed flow, contribute approximately one-third of the waste load received by the Rappahannock River in the Fredericksburg Area.

a. Existing and Potential Problems

Serious water quality problems exist in the Rappahannock River below Fredericksburg. The quality of the River varies with River discharges and tides, but for the lower range of flows (less than 500 to 700 cfs), when fresh water inflow is not sufficient to overcome tidal effects, wastes accumulate in the

upper estuary creating seriously degraded conditions. Dissolved oxygen concentrations are reduced to zero; fish kills occur; and the River becomes generally undesirable for most legitimate uses.

Nutrients contributed by Fredericksburg Area treatment plants could adversely affect water quality in the Rappahannock Estuary; however, sufficient data are not presently available to afford an evaluation of the problem.

Assimilative capacity studies of the Rappahannock River made by the U. S. Public Health Service in 1964* indicate that the River can assimilate approximately 2000 pounds of BOD during low flow periods and maintain a minimum average D.O. concentration of 4 mg/l. Projections indicate that waste loads in the Area will be as follows:

Type	Discharge in Pounds of 5-Day BOD		
	Present	1980*	2000*
Municipal	1,800	1,325	1,840
Industrial	8,200	2,100	2,680
Total	10,000	3,425	4,520

* Assuming 85 per cent removal of BOD

* Water Resource Study - Salem Church Reservoir, Rappahannock River, Virginia, U. S. Department of Health, Education, and Welfare, Public Health Service, Region III, Charlottesville, Virginia.

It is obvious that water quality problems will still exist after all wastes receive secondary treatment, unless additional measures are taken.

b. Action Pending and Required

The industrial plant and all municipalities in the Area have been directed by the State Water Control Board to begin construction of secondary treatment facilities by June 1, 1967. In response to the directive, action has been as follows:

(1) Fredericksburg

The City of Fredericksburg has submitted plans for secondary treatment facilities to the State Department of Health for approval. The proposed facilities include a high rate trickling filter designed for a population equivalent of 28,000 and a BOD removal of 85 per cent. The estimated cost is \$570,000.

State agencies have approved the plans and forwarded them to the Federal Water Pollution Control Administration with an application for a Federal grant.

(2) Falmouth, Ferry Farms, and Tylerton

A Sanitary District for the southeast portion of Stafford County, which would include Falmouth, Ferry Farms, Tylerton, and other areas of the County in the Rappahannock Basin, has been proposed, and a referendum is being planned for May 1967. If the referendum is approved, a secondary waste treatment plant

designed for a population equivalent of 4,000 would be constructed to serve the newly created Sanitary District, with the exception of a small area in the Potomac Watershed. The plant, as proposed, would be the contact stabilization type and would discharge to the Rappahannock River between Falmouth and Fredericksburg. The estimated total cost of the sewerage system for the proposed Sanitary District is \$950,000.

(3) Food Machinery Corporation, American Viscose Division

In compliance with the State Water Control Board directive, the American Viscose cellophane plant has started construction of secondary treatment facilities. The proposed treatment plant will be designed to treat approximately 10 mgd, or one-third of the waste discharge. The process will consist of neutralization, nutrient additions, contact aeration, and clarification. The Company has proposed that the treatment plant be operated for one year as a pilot plant, after which time additional units will be constructed to treat all of the industry's wastes. It is estimated that BOD removals will be on the order of 60 to 65 per cent. The estimated cost of the initial unit is \$800,000.

(4) General

The apparent need for flow regulation to maintain water quality below Fredericksburg after secondary treatment facilities are installed has been recognized and provided for in planning

for the proposed Salem Church Reservoir which would be located approximately six miles upstream from Fredericksburg. Studies made by the Public Health Service indicated that 130,400 acre-feet of storage will be required to maintain water quality below Fredericksburg through the year 2020, assuming that secondary treatment for all Fredericksburg Area wastes will be provided.

If the dam is constructed, based on the aforementioned study, a minimum average D.O. value of 4 mg/l could be maintained.

If the dam is not constructed, alternate methods of reducing waste loads which could be considered are: (a) flow diversion to points further downstream or to the Potomac River, which is approximately ten miles from Fredericksburg; and/or (b) advanced waste treatment of area wastes.

Population projections indicate a need for additional waste treatment facilities for municipal wastes after 1980 in the Fredericksburg Area. Proposed new facilities are designed for 1980 populations.

C. Lower Area

The Lower Basin is essentially a rural area with approximately 95 per cent of the population residing on farms or in rural residential areas.

The six incorporated towns in the region are all small, the largest having a population of approximately 1,100. Industries in the Lower Basin having waste discharges are seasonal,

and industrial pollution problems originating in the Area are primarily localized nuisance problems.

The River has a 12-foot minimum depth navigable channel over the entire tidal portion from the mouth to Fredericksburg, a distance of 107 miles. Twelve Federally improved small boat harbors on tributaries of the lower reaches of the River are used extensively by commercial seafood boats and recreational craft.

Highly productive oyster grounds are located in the lower Rappahannock River, the reach from Towles Point upstream to Bowlers Wharf being the principal oyster growing area in the State. The Estuary also serves as a spawning area for shad and striped bass.

Projections indicate that growth in the lower region will be moderately small, with only about a 33 per cent increase expected by the year 2000.

No single town is causing major pollution problems in the lower reaches of the River; however, there is a need for sewerage systems to replace septic tanks in two towns, and several existing plants need attention. The principal pollution problems are localized and are related to boat pollution.

A summary of pollution in the Lower Basin follows:

1. King George County

The only significant source of waste in the County is the Engelhorn Meat Packing Company, located near Dogue, Virginia, which discharges waste to a holding pond and uses the pond discharge for spray irrigation of about 1,000 acres. Feed lots for fattening pigs are located in the Area; however, the feeding operation has been reduced. Presumably there is no effluent to the River; however, the State Water Control Board is monitoring the Area to assure that no pollution problem is created by run-off.

2. Westmoreland County

A small cannery at Leedstown creates localized seasonal nuisance conditions when pulp wastes from tomato canning operations are discharged to the River. Methods of alleviating the problem are being studied cooperatively by the owner and the Water Control Board.

3. Essex County

The Town of Tappahannock, the largest in the Lower Basin, has a stabilization pond with sufficient capacity for future needs. No pollution problems are evident in this County.

4. Richmond County

The Town of Warsaw, with an approximate population of 500, is served by septic tanks and has been seeking financial aid for several years for the construction of a sewerage system

for the Town. An attempt is being made to acquire financing through the Farm Home Administration. The proposed town sewerage system would discharge to Jugs Creek, a small tributary of the Rappahannock River. The system would cost an estimated \$650,000.

Clothing manufacturers located near the Town treat their own waste in a stabilization pond which discharges to Cat Point Creek. No significant water quality problems exist in the Area; however, the Town desires to construct public sewers to enhance growth.

5. Lancaster County

No serious water quality problems exist in this County; however, Kilmarnock, the second largest Town in the Lower Basin with a 1960 population of 927, has local problems, including suspected bacterial pollution of Corrotoman River, Eastern Branch, resulting from several municipally owned septic tanks which discharge to small stream. The Town has recently voted against a referendum which would have authorized a construction program including a two-acre lagoon in the Rappahannock Basin. The estimated cost of the Project was \$127,000; however, the Town is restudying sewerage needs in anticipation of holding a new referendum, and cost estimates may be increased.

The only other significant pollution problems in the County are related to boating activities. Bacterial pollution

in Carters Creek and Windmill Point Areas has caused the State Department of Health to place restrictions on the direct marketing of shellfish from beds in the area. The Tides Inn resort at Irvington has a privately owned secondary plant which is adequate to treat the wastes from the resort; however, improper operation in the past has contributed to the pollution problem in Carters Creek. This problem is being handled by the State Water Control Board.

At the mouth of the River, a yacht basin at Windmill Point has secondary facilities.

6. Middlesex County

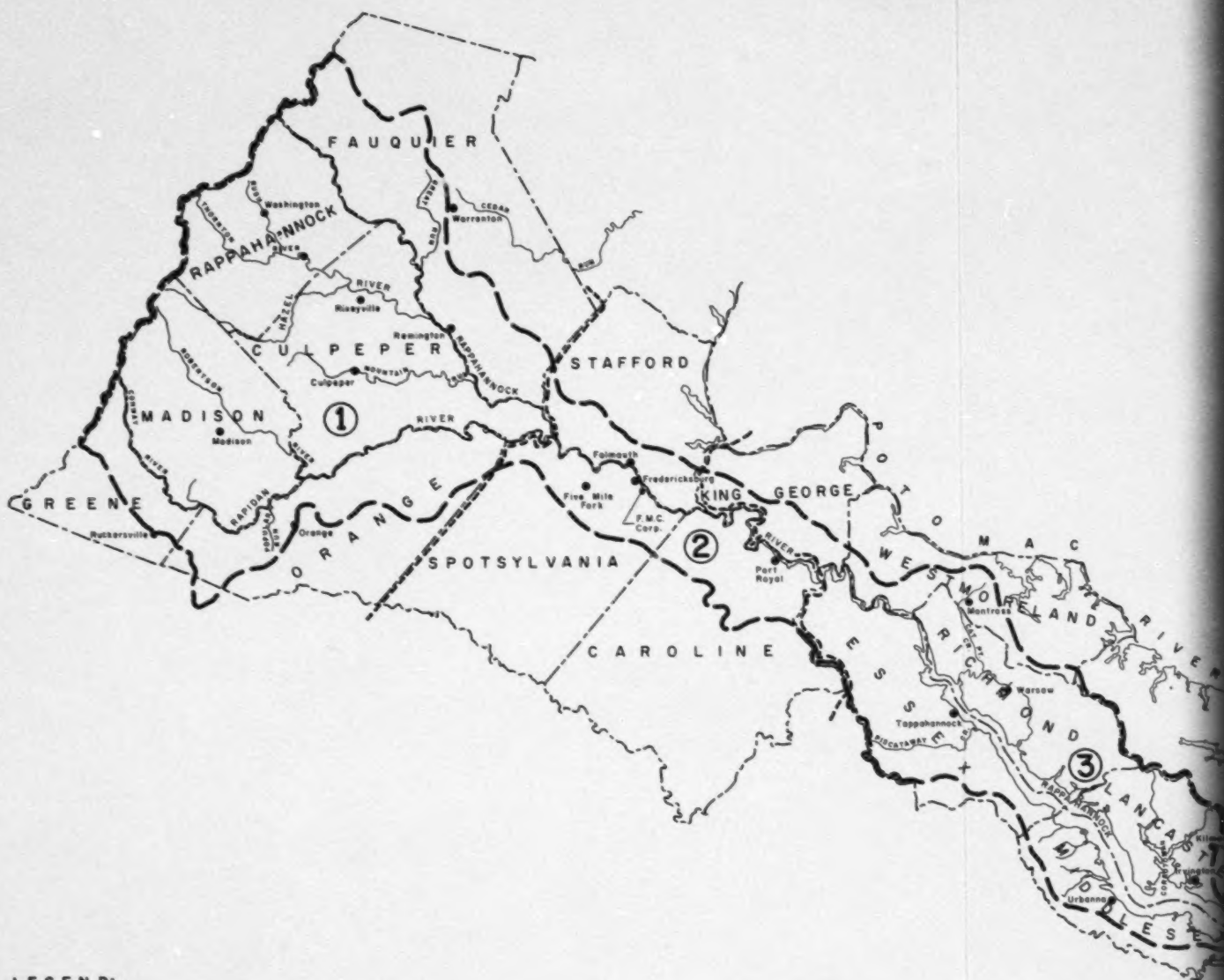
The principal problem in the County is related to a yacht basin in Urbanna Creek where the direct marketing of shellfish is condemned. The pollution stems from boat activity in the area and from a structurally unsound and outmoded primary waste treatment plant serving the Town of Urbanna. The Water Control Board has not yet directed that additional facilities be provided, primarily because of the need for additional studies of the boat pollution problem.

Barndardt Farms Inn, a duck farm downstream from Urbanna, has a series of settling and retention ponds for treating discharges from duck runs. The final effluent is not chlorinated before discharge to the Rappahannock River; however, a review of

Water Control Board data collected during a six-month study of the facilities^{*} resulted in the State Department of Health's lifting of restrictions on direct harvesting of oysters from approximately 400 acres of public shellfish beds. The data also showed the water quality in the Area to be satisfactory for recreational purposes except in the immediate vicinity of the treated discharges.

The only other significant pollution problem in the County is in the Broad Creek area near the mouth of the River, where bacterial pollution attributable to intensive boat activity has resulted in the condemnation of shellfish beds.

* "Treatment of Duck Wastes and Their Effects on Water Quality," R. V. Davis, C. E. Cooley, and A. W. Hadder, Virginia State Water Control Board.



LEGEND:



INDICATES THE HEADWATER, CENTRAL & LOWER AREAS



INDICATES THE AREA BOUNDARIES

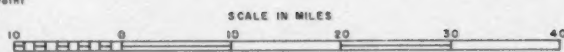
B



LOCATION MAP



N



WATER QUALITY & POLLUTION CONTROL STUDY
CHESAPEAKE BAY DRAINAGE AREA

RAPPAHANNOCK
RIVER BASIN

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
MIDDLE ATLANTIC REGION CHARLOTTESVILLE, VA.

FIGURE 1